

Feb. 27, 1968

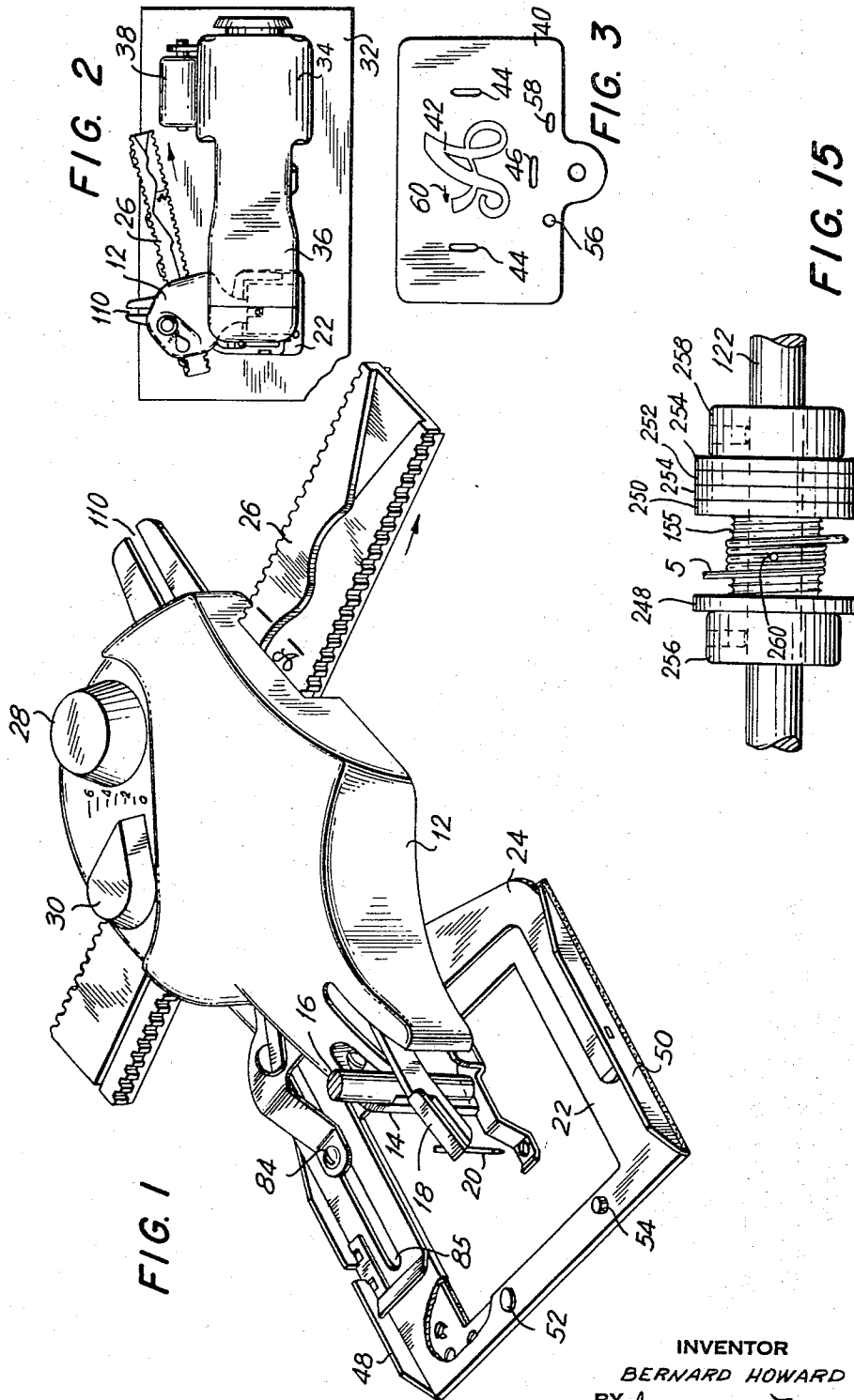
B. HOWARD

3,370,509

CAM GENERATOR, PARTICULARLY FOR SEWING MACHINE ATTACHMENT

Filed Jan. 5, 1966

6 Sheets-Sheet 1



INVENTOR
BERNARD HOWARD
BY *James and Franklin*
ATTORNEYS

Feb. 27, 1968

B. HOWARD

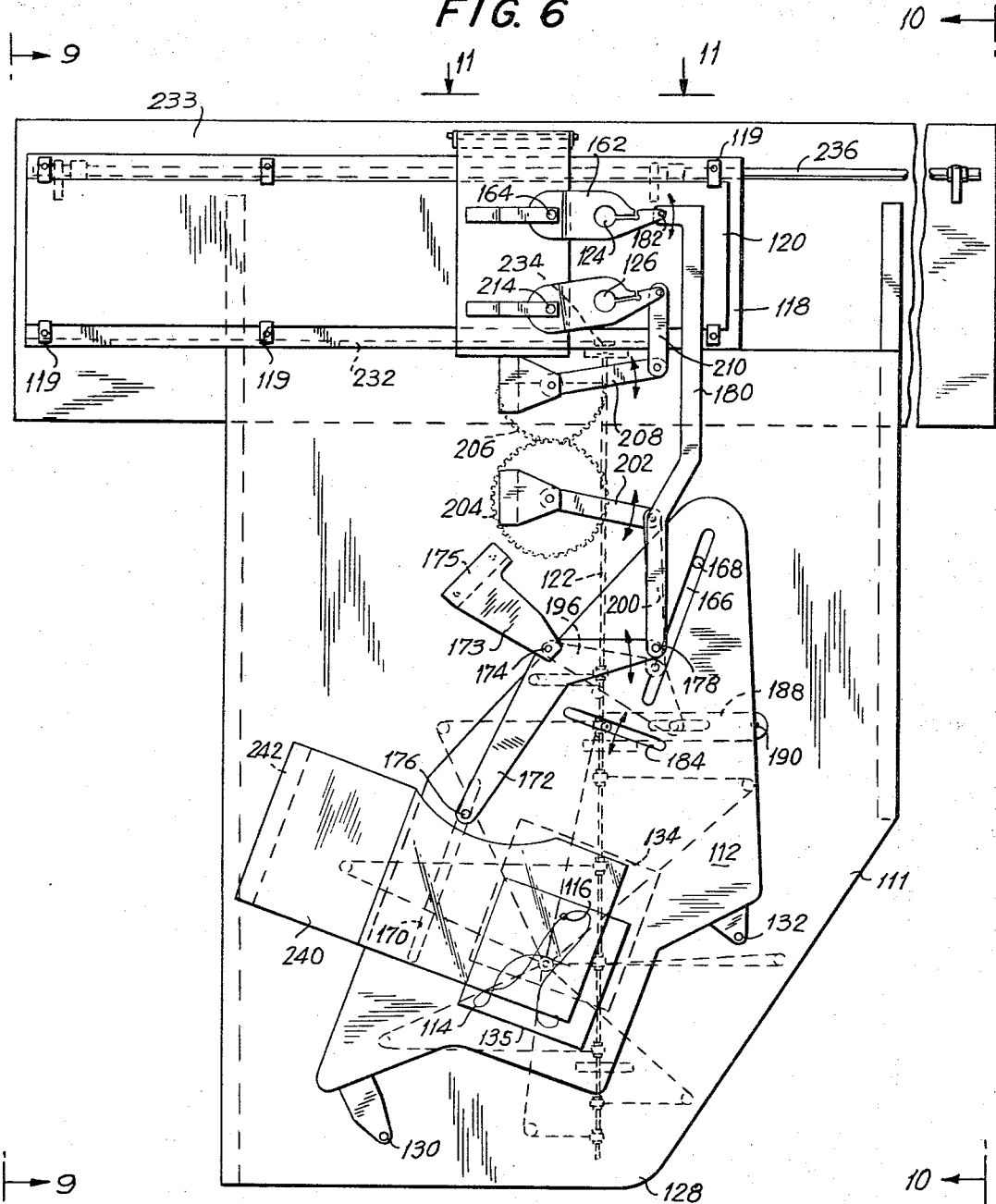
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CAM GENERATOR, PARTICULARLY FOR SEWING MACHINE ATTACHMENT

Filed Jan. 5, 1966

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FIG. 6



INVENTOR.
BERNARD HOWARD

BY

James and Franklin

ATTORNEYS

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B. HOWARD

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6 Sheets-Sheet 4

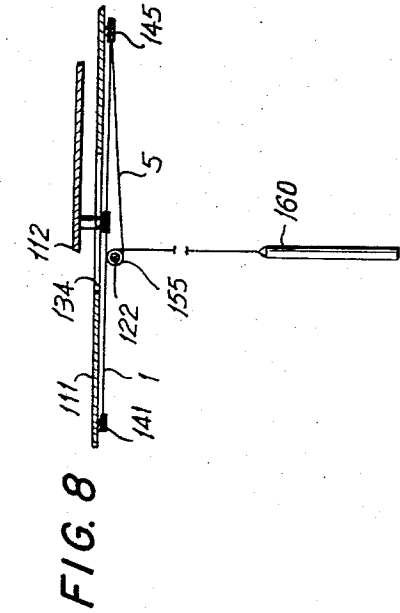


FIG. 8

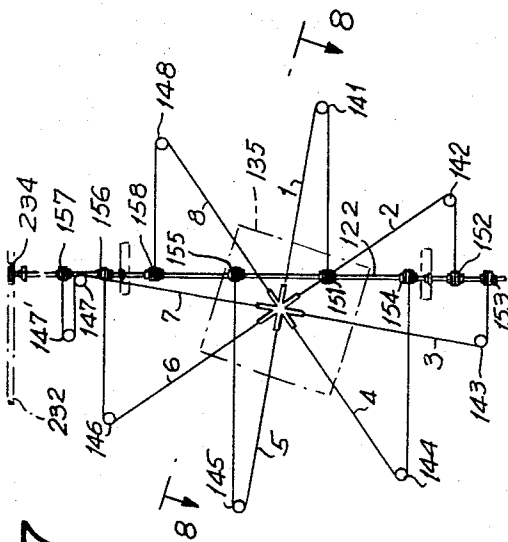


FIG. 7

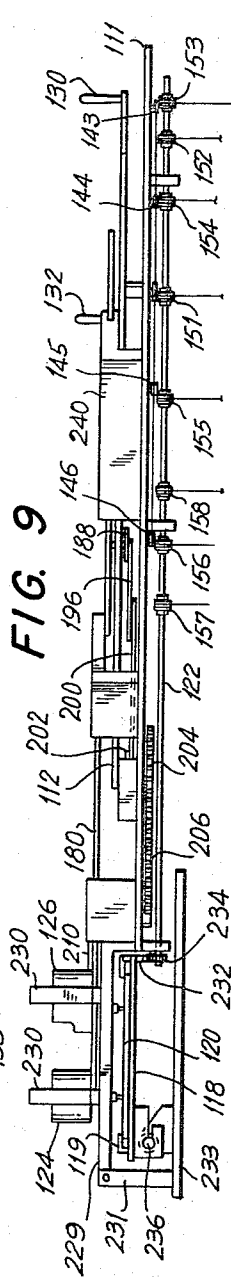


FIG. 9

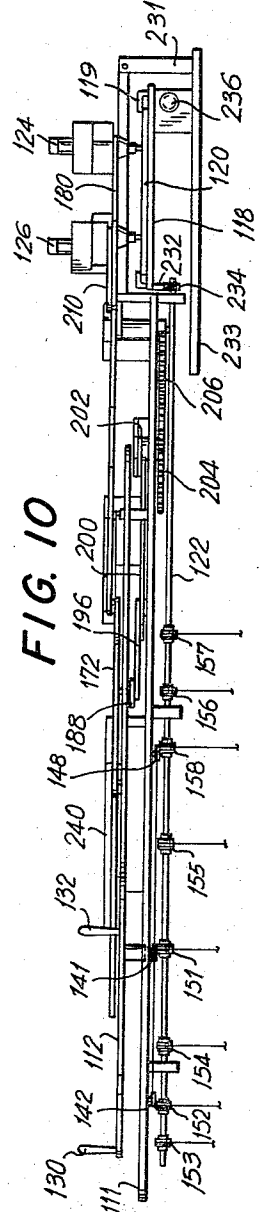


FIG. 10

INVENTOR.
BERNARD HOWARD

BY

James and Franklin

ATTORNEYS

Feb. 27, 1968

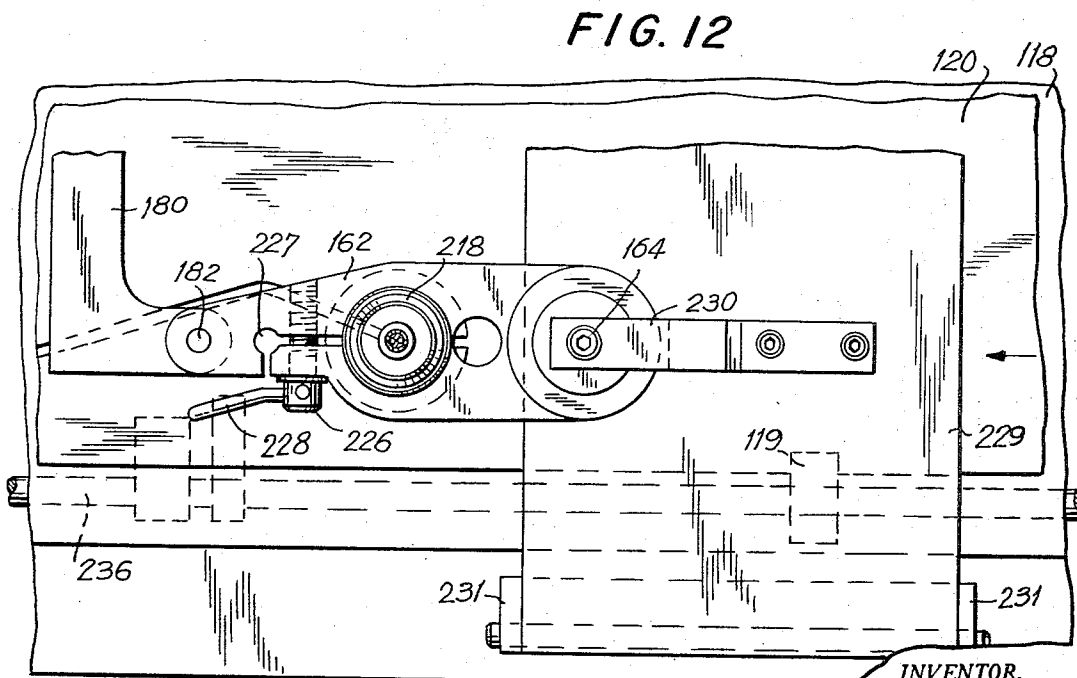
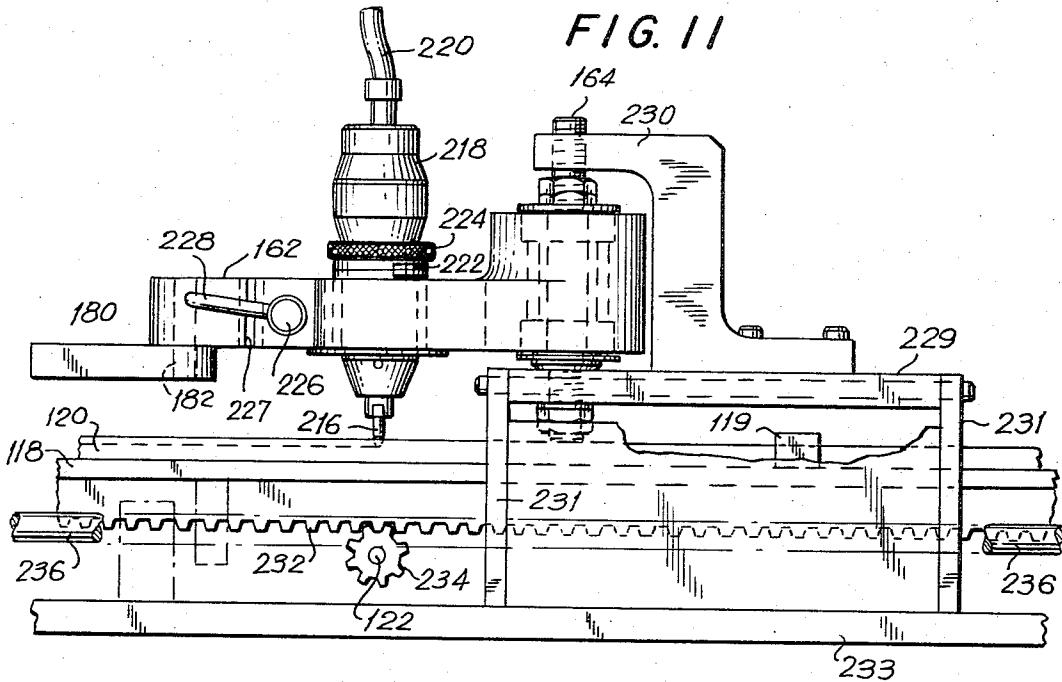
B. HOWARD

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CAM GENERATOR, PARTICULARLY FOR SEWING MACHINE ATTACHMENT

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6 Sheets-Sheet 5



INVENTOR.

BERNARD HOWARD

BY

James and Franklin

ATTORNEYS

Feb. 27, 1968

B. HOWARD

3,370,509

CAM GENERATOR, PARTICULARLY FOR SEWING MACHINE ATTACHMENT

Filed Jan. 5, 1966

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FIG. 14

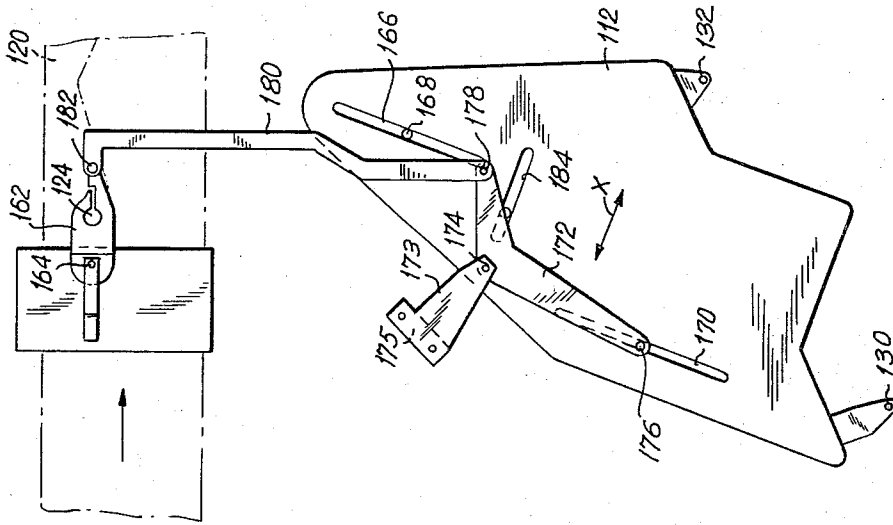
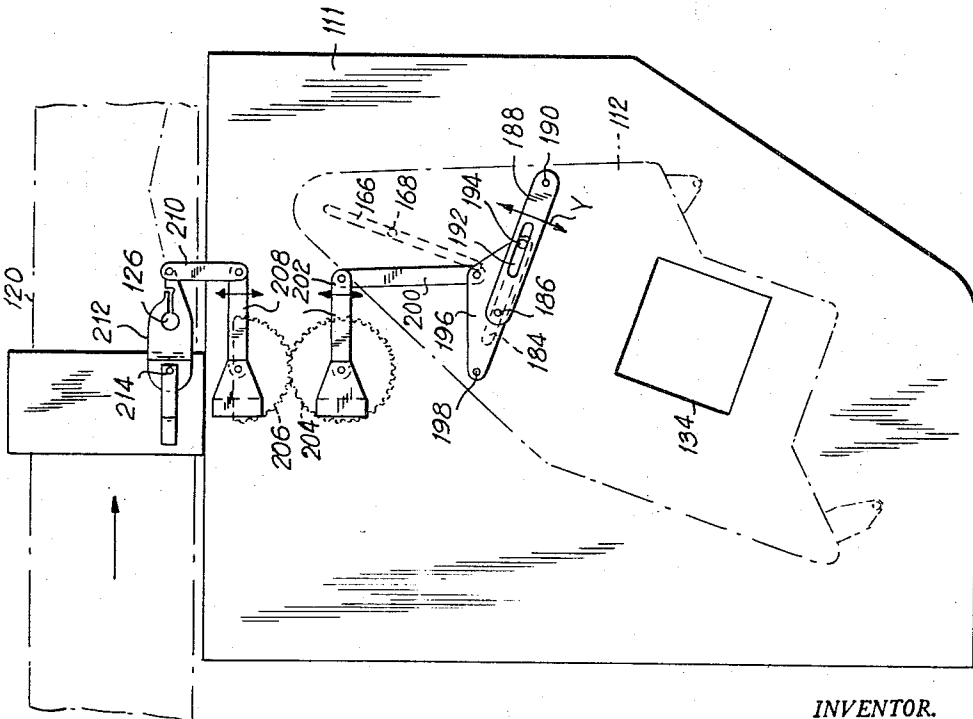


FIG. 13



INVENTOR.
BERNARD HOWARD

BY

James and Franklin
ATTORNEYS

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3,370,509

CAM GENERATOR, PARTICULARLY FOR
SEWING MACHINE ATTACHMENTBernard Howard, New Haven, Conn., assignor to Mite
Corporation, New Haven, Conn., a corporation of
DelawareFiled Jan. 5, 1966, Ser. No. 518,933
10 Claims. (Cl. 90-13)

This invention relates to cam generators, and more particularly to a cam generator for making a cam pattern to be used for a sewing machine attachment for sewing monograms.

In my copending application Ser. No. 482,466, filed August 25, 1965, and entitled, "Sewing Machine for Making Monograms and Other Designs," I disclose an easily used attachment for making monograms, button holes, words, pictures, and other intricate designs. For this purpose the fabric is moved by a relatively large foot in the form of a hollow frame, and the foot is given a lateral or X motion, and a longitudinal or Y motion, produced by two appropriately coordinated cam tracks on a single cam.

The cam is an elongated flat bar so that the design produced within the foot is not limited in length, the bar being longer for a longer design. The stitch is a zigzag stitch which may be produced by the attachment itself.

The general object of the present invention is to provide a cam generator for easily and accurately making the cam pattern needed for the sewing machine attachment. A more specific object is to provide a machine on which an enlarged specimen monogram may be mounted, and which provides appropriate cam grooves for the X and Y movements by tracing the monogram manually.

The speed of movement of the cam bar through the sewing machine attachment depends on the operating speed of the machine and therefore is in proportion to the number of stitches. The displacement in X and Y direction should be such as to properly distribute the zigzag stitches in the monogram, and that in turn would be related in the cam generator to the speed at which the monogram is being traced. An important feature of the present invention therefore is to move the master cam bar solely in response to tracing of the monogram, and in proportion to the amount of tracing movement.

To accomplish the foregoing general objects, and other more specific objects which will hereinafter appear, my invention resides in the cam generator, and the elements thereof, and their relation one to another, as are hereinafter more particularly described in the following specification. The specification is accompanied by drawings in which:

FIG. 1 is a perspective view showing the sewing machine attachment with a pattern cam bar therein;

FIG. 2 is a plan view drawn to small scale to show the relation of the attachment and its cam bar to the sewing machine;

FIG. 3 shows a thin transparent locating guide which helps properly locate the monogram on the fabric;

FIG. 4 is a plan view explanatory of the linkage in the attachment for producing the lateral or X movement;

FIG. 5 is a plan view explanatory of the linkage in the attachment for producing the longitudinal or Y movement;

FIG. 6 is a plan view of the cam generator;

FIG. 7 is a schematic plan view explanatory of the mechanism for moving the master cam carriage;

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FIG. 8 is a fragmentary vertical section through the same, in a form using weights;

FIG. 9 is a side elevation looking approximately in the direction of the arrows 9-9 of FIG. 6;

FIG. 10 is a side elevation looking in the direction of the arrows 10-10 of FIG. 6;

FIG. 11 is an elevation looking in the direction of the arrows 11-11 of FIG. 6;

FIG. 12 is a fragmentary plan view of the cutting tool shown in FIG. 11;

FIG. 13 is a plan view of the linkage for producing the Y movement;

FIG. 14 is a plan view of the linkage for producing the X movement; and

FIG. 15 is an elevation of one of the drum and clutch units.

The cam generator is illustrated by and will be described in connection with FIGS. 6-14 of the drawing. However, it will be helpful to first review the nature of the sewing machine attachment in which the cam bar is to be used, and this may be done with reference to FIGS. 1-5 of the drawing.

The attachment is shown in FIG. 1. Its mechanism is enclosed by a removable cover 12, and it is secured to the sewing machine by an adapter 14 which is mounted on the presser bar 16 of the sewing machine. It is actuated by a fork arm 18 which straddles the clamp screw of the needle bar (not shown) which carries the sewing machine needle 20. The fabric is held and moved by a foot in the form of a frame 22, which is carried and moved by the bifurcated forward end of a slide 24 located at the very bottom of the attachment mechanism.

The slide is given both lateral and longitudinal movements, referred to as X and Y movements respectively, by means of an elongated flat cam bar 26 which is fed through the attachment from left to right as the sewing operation proceeds. A manually operable knob 28 may be used to position the cam 26 when first inserting it in the attachment. Another knob 30 varies the range of zigzag stitch width or bight.

Referring now to FIG. 2, a sewing machine is schematically represented by a base 32 carrying a head 34 with an overhanging arm 36, and driven by a motor 38. The monogram attachment is shown at 12, with a cam 26 which has already moved nearly all the way through the attachment. It will be noted that the cam 26 is disposed at an angle such that its path of movement clears the sewing machine head 34 and the motor 38 regardless of the length of the cam. This is important when the design is intricate and requires a long cam which otherwise could not be accommodated.

Referring to FIG. 3, each cam preferably is accompanied by a thin transparent plastic guide 40 on which the character or design to be produced by the cam is indicated in correct size and location. In this case a script A is shown at 42. The guide 40 has two vertical marking slots 44 and a horizontal marking slot 46. To help accurately locate the monogram on the material, the guide is first placed on the material and three light pencil lines are made through the slots. The slots correspond to the inner edges of the foot frame 22 (FIG. 1), and thus the material may be placed in the sewing machine beneath the foot frame, and the design reproduced in correct location.

Another procedure is to place the guide 40 in the foot frame between its side flanges 48 and 50. The foot frame

is provided with studs 52 and 54, and the guide has mating holes 56 and 58. The material is moved about beneath the foot frame until the design is located as desired, whereupon the guide is removed.

A small arrow may be provided on the guide, as indicated at 60 to show the proper starting point of the needle when reproducing the particular design.

The guide is also useful if a shade line stitch is wanted, or to stitch several successive large letters to form a large monogram, or to sew a border which is to be stitched continuously around a piece of material.

The linkage for giving the foot and cloth a lateral or X motion is shown in FIG. 4, and the linkage for giving the cloth a longitudinal or Y motion is shown in FIG. 5. Referring first to FIG. 4, the top cam groove 66 of the cam 26 receives a cam follower pin 68 projecting downward from an angle lever 70 pivoted on a fixed pivot located at 72, and separate from the pivot 74 of a combining lever 76 used to add in a zigzag stitch motion. The pivot 72 is a fixed pivot, and at times the movable pivot 74 is located over the pivot 72. Pivot 72 is conveniently located directly over another fixed pivot 78 (FIG. 5) which is carried by the base 80 and which is located below the cam bar 26. For ease in designing the cam tracks for symmetrical movement either side of center, the fixed pivots 72 and 78 are preferably located half way across the width of the cam bar.

The cam follower 70 (FIG. 4) is an angle lever, pivoted at 72, and carrying a connection pivot 82 for the combining lever 76. The cam groove 66 may move pivot 82 to the broken line position 82', thereby moving the pin 84 in slot 85 to the broken line position 84', and so moving the slide 24 to the broken line position 24'. It is capable of an equal movement in opposite direction, thus providing the lateral or X movement. Without the zigzag motion the pivots 72 and 74 could be joined, and lever 76 would become simply a part of the angle lever 70.

The mechanism for producing the longitudinal or Y motion (FIG. 5) is located below the cam bar. The Y motion is obtained from a cam groove formed in the bottom of the cam bar. The cam groove receives a cam follower pin 86 projecting upwardly from a cam follower arm 88 pivoted on a fixed pivot 78 secured to the base 80. The arm 88 is widened at 90, and also at its movable end 92, to steady it and the cam 26 resting thereon.

Its motion is multiplied by a multiplier lever 94 pivoted at 96. The follower arm 88 is connected to the multiplier lever 94 by means of a pin 96 projecting downward into a slot 98 in the arm 94, which slot accommodates the angularity. The movable end 100 of multiplier lever 94 has a pin 102 which is received in a transverse or lateral slot 104 formed directly in the main slide 24. It will be recalled that the slide 24 is located beneath the base 80, and in the present mechanism the arm 94 is located beneath the base and between the base 80 and the slide 24. The pin 96 passes through an arcuate slot 106 in the base 80, in order to reach the multiplier lever 94 below the base.

The base 80 has a fixed downwardly projecting pivot 108 which is received in a long slot 110 in the rear end of the slide 24, this slot being shown in FIGS. 1, 2 and 5. The slide turns on pivot 108 for its lateral or X movement, and slides on pivot 108 for its longitudinal or Y movement. The movements are arcuate rather than rectilinear, but the design of the cam tracks allows for this.

Referring now to FIG. 6 the cam generator comprises a movable table 112 on which a specimen monogram may be mounted, as here indicated by the script A shown at 114. There is a pointer 116 relative to which the table 112 is moved to trace the monogram 114. This may be on paper indicated at 135.

An elongated cam carriage 118 is mounted for longitudinal movement and arranged to carry a blank cam bar 120. There is also means including a rotatable drive shaft 122 to move the carriage 118. A cutting tool at 124

for cutting the X groove, is movable transversely of the carriage 118. Another cutting tool at 126 is movable transversely of the carriage 118 and serves for cutting the Y groove. There is a linkage between the table 112 and the tool 124 for response to movement of the table in X direction, and an additional and separate linkage between the table 112 and the Y tool 126 for response to movement of the table in the Y direction. The tools have high speed rotatable cutters on vertical shafts. There is also a means to rotate the drive shaft 122, described later.

The cam bar 120 being cut is an enlarged master cam to be used in making smaller cam bars for the sewing machine attachment, and the monogram 114 is an appropriately enlarged monogram. In practice the cam bars used in the sewing machine may be injection molded out of a suitable plastics material, in which case the master cam bar 120 is used to first make an intermediate master, which in turn is used to make the mold in which the plastic cam bars are molded.

An important feature of the present invention is that the drive shaft 122 is rotated in response to the tracing movement of the table 112, there being no movement of the cam carriage 118 when the table 112 is stationary. An operator is seater near the point 128, and holds two spaced upright handles indicated at 130 and 132. Changes in the speed at which he moves the table 112 to trace the monogram do not spoil the spacing or density of the stitching produced subsequently by the sewing machine when sewing the monogram, because the rotation of drive shaft 122 is made proportional to the amount of tracing movement of the table 112 relative to the pointer 116.

The manner in which this result is accomplished may be explained with reference to FIG. 7 of the drawing, referring to which there are cables 1, 2, 3, 4, 5, 6, 7, and 8 radiating from the table in angularly spaced directions. The angular spacing is uniform when the monogram patch, here indicated by broken lines 135, is in midposition. The angular spacing changes slightly when the table is moved about to trace the monogram. The cables are below the fixed base 111 (FIGS. 6 and 8), and table 112 has a post passing downward through a large opening 134 in base 111 to connect all eight cables to the table 112.

There are pulleys 141, 142, 143, 144, 145, 146, 147, and 148 (FIG. 7) guiding all of the cables to drums 151, 152, 153, 154, 155, 156, 157, and 158 spaced along the drive shaft 122. Each drum carries within it, or adjacent to it, an overrunning or unidirectional clutch which is operative between the drum and the drive shaft, and all of the clutches are faced in the same direction, that is, they engage in the same direction of rotation. The clutches may be of the type described in my Patent 2,965,204, issued Dec. 20, 1960, and entitled "Multiple Clutch." However, the half-revolution stop teeth and stop fingers there shown are not needed for the present purpose. Each clutch body is secured to a drum, as described later, and the shaft 122 extends continuously through all of the drums and clutch bodies. It will thus be apparent that at any one instant the drive shaft 122 is turned by that cable having the greatest or fastest movement at that instant.

Thus the speed of movement of the cam bar is substantially uniformly related to the speed at which the monogram is being traced at any instant, whether the motion is steady or irregular or even intermittent, and whether it is predominantly in X direction or Y direction or a combination of both. In the present case there are eight cables disposed at an angular spacing of forty five degrees, but it will be understood that a greater or lesser number may be employed, depending on the accuracy desired.

In FIG. 7 it will be seen that there are two pulleys 147 and 147' for the cable 7, in order to bring the working part of the cable approaching the drum 157 to a position perpendicular to the shaft 122. Each of the other

pulleys is so positioned relative to the location of its drum along the drive shaft 122, that its cable approaches the shaft substantially at right angles to the shaft.

Referring to FIG. 8, each cable, for example the cable 5 shown, after being wound repeatedly about and preferably being secured to its drum 155, may extend downward to a weight 160, which serves to take up slack and to keep the cable taut when the table is moved toward instead of away from the cable. Thus, in FIG. 8, if the table is moved to the right, the cable 5 would tend to go slack and the cable 1 would be operative to turn the shaft 122. Each cable may be provided with such a weight, but other means, for example a spring, may be employed for the same purpose. The drums may each have a spiral or helical spring which is tensioned when its cable is pulled, and which rewinds the cable when the cable is slack. However, hanging weights have the advantage that the tension is uniform regardless of the traverse of the table.

The linkage for producing the X motion of the tool 124 is shown separately and may be described with reference to FIG. 14. The tool is clamped in an arm 162 pivoted at 164, and is moved transversely of the master cam bar shown in broken lines at 120. This may be made of a suitable material, preferably Lucite, which has no grain, and therefore cuts as easily in one direction as another. The table 112 corresponds generally to the foot 24 shown in FIGS. 1-5, and it has a longitudinal slot 166 receiving a fixed pin 168 on which the table may be moved both longitudinally and laterally by means of the spaced-apart handles 130 and 132 previously mentioned. Parts 166 and 168 correspond to the slot 110 and pivot 108 shown in FIG. 5.

The table 112 has an offset slot 170 which corresponds to the slot 85 shown in FIGS. 1, 4 and 5. An angle arm 172 is pivoted on a fixed pivot at 174, and is connected to the table by means of a pin 176 received in the slot 170. This responds to motion of the table in the direction of the narrow marked X, that is, to a lateral motion relative to the monogram. The other end of lever 172 is connected at 178 to a link 180 which extends to the tool arm 162, the latter parts being connected at 182. This linkage is an enlarged mechanical analog of the linkage shown in FIG. 4, but with the combining lever 76 and the angle lever 70 locked together as one lever, because in the link of FIG. 14 there is no problem of combining the X motion with a zigzag stitch motion.

The linkage of FIG. 14 is located above the table 112, the pivot 174 being carried on an arm 173 mounted on a block 175 to raise it above a base plate 111 omitted in FIG. 14 but shown in FIG. 13. (The Y linkage is below the table.)

The linkage for moving the cutting tool 126 in accordance with the Y motion of the monogram is shown separately and may be described with reference to FIG. 13 of the drawing. The table 112 is shown in broken lines, because this linkage, while above base plate 111, is beneath the table 112. As before, the table 112 is moved on pin 168 received in a longitudinal slot 166. The table has a transverse slot 184 (shown in solid lines in FIG. 14). This slot is linked by a pin 186 to a motion reducing lever 188 pivoted on a fixed pivot 190. Lever 188 has a slot 192 receiving a pin 194 on a lever 196 which is pivoted on a fixed pivot 198. Lever 196 is connected to a link 200 which could extend directly to the tool 126 which cuts the Y groove. On reflection it will be seen that this linkage is a mechanical analog of the linkage shown in FIG. 5 of the drawings, the motion reducing lever 188 in FIG. 13 corresponding to the motion multiplying lever 94 in FIG. 5.

In making the master cam bar 120 it is convenient to cut both X and Y grooves on top of the lucite bar, both cutting tools and their driving motors being carried above the carriage and the bar 120 moved thereby. However, the top Y groove is used later to produce a bottom Y groove on a cam bar, or on an intermediate master, as previously

mentioned, and it is therefore convenient to make the Y groove on the master 120 a "mirror image" of the bottom Y groove. For this purpose the output of the Y linkage at 200 (FIG. 13) is reversed before being applied to the cutting tool 126. In the present case this is done by means of meshing gears, but other methods may be employed. Specifically the link 200 is connected to an arm 202 which is secured to and turns a gear 204. The latter meshes with a gear of like radius 206, which then turns an arm 208 having the same length as the arm 202. The arms are parallel when in midposition. The arm 208 is connected by a link 210 to the clamp arm 212 which carries the tool 126. The clamp arm 212 is pivoted at 214.

In both FIG. 13 and FIG. 14 the motion at the tool is reduced compared to the motion of the linkage, because of the clamp lever, and in the present case, the motion is cut in half in both cases. In the present case the gears 204 and 206 are located beneath plate 111, and their shafts extend through the plate, as shown in FIGS. 9 and 10.

The linkage responds to the Y motion, which is in the direction of the arrow indicated at Y (FIG. 13). It may be observed that in FIG. 14 the X motion is inclined relative to the horizontal, and in FIG. 13 the Y motion is inclined relative to the vertical. This inclination will be understood on reference to FIGS. 1-5, it being recalled that the cam bar 26 in FIG. 2 is disposed at an angle so that it will clear the sewing machine parts such as the motor 38, regardless of the length of the cam bar. Thus the X and Y motions, which are horizontal and vertical in FIG. 2, are inclined relative to the cam bar, and there is a similar inclination in FIGS. 6, 13 and 14. This also explains the inclined position of the monogram in FIG. 6, it being convenient to draw the cam bar horizontally in the drawing, instead of inclining it as shown in FIG. 2.

If in FIG. 2 the attachment 12 were designed to move the cam bar 26 in horizontal direction, then in FIG. 6 the cam bar would be parallel to the X axis, and the drive shaft 122 would be parallel to the Y axis. The monogram would be erect instead of inclined. However, because the cam bar 26 is inclined in the attachment of FIG. 2, the cam bar and drive shaft 122 in FIG. 6 are similarly and equally inclined relative to the X and Y axes.

The mounting of the tools may be described in greater detail with reference to FIGS. 11 and 12 of the drawing. The cutter is shown at 215, it being driven by a high speed air motor 218 supplied through a flexible air hose 220. The height of the tool or groove depth may be adjusted by means of a threaded bushing 222 having a capstan head 224, and the adjustment is locked by means of a clamp screw 226 operated by a handle 228. The manner in which the arm 162 is split at 227 to receive the clamp action of screw 226 will be clear from inspection of FIG. 12. These views also show how the link 180 is connected to the arm 162 at 182, to move the tool transversely of the longitudinal path of movement of the cam strip. The arm 162 turns on bearings carried by a fixed threaded spindle 164 which is securely mounted in spaced supports, the upper support being shown at 230, and being mounted on a plate 229, which is itself carried on legs 231 carried by a base 233 and straddling the cam carriage 118.

FIG. 11 also shows how the rotation of the drive shaft 122 is applied to the carriage 118 to move the cam blank 120. For this purpose the carriage 118 is provided on its underside with a gear rack 232, and shaft 122 carries a pinion 234 meshing with the gear rack 232. To insure accurate sliding movement of the carriage it preferably slides on a sturdy fixed guide rod 236, most of which is broken away in FIG. 11 in order to better show the gear rack 232 which is on the remote side of the carriage. The plastic sheet or bar 120 is locked on the carriage 118, as by means of clamp strips 119 at the edges of the carriage, each tightened by a clamp screw.

Reverting to FIG. 6, in the present case the pointer 116 is a dot on a rigid piece of transparent plastic 240 fixedly carried above the table 112 and the monogram

thereon, by means of a support or block 242 which is far enough away from the table not to interfere with the tracing movement thereof. Block 242 is fixed on plate 111. It will be understood that crossed lines instead of a dot may be used on the transparent piece 240, and that a slender pointer may be used instead of a plate. However, the plate is preferred, because of its greater strength if accidentally struck or engaged.

The motion of the monogram and the table carrying the same is reduced by half at the air motor, because of arms 162, so that the cam groove displacement from side to side is twice that to be provided on the actual cam bar. This groove displacement is reduced two to one by pantograph when transferring the cam groove from the master cam 120. The width of the master cam is large enough to allow for the fact that there are two cam grooves side by side, and to provide clearance for the air motors, should they move toward one another, and to provide clearance at the edges of the Lucite master cam for clamping it on the carriage 118 by means of the small clamp strips 119.

It will be understood therefore that the scale of the drawing in FIGS. 1-5 is greatly enlarged relative to that in FIG. 6. In practice it is convenient to employ a large original monogram, and to make a large plastic master cam. In the specific example shown the small cam bar used in the attachment has a width of $1\frac{3}{16}$ inches, and the displacement of either cam groove from center is a maximum of $\frac{7}{16}$ inch, whereas in FIG. 6 the master cam strip 120 has a width of $7\frac{7}{8}$ inches and the maximum displacement of each cam groove from center is a matter of $\frac{7}{8}$ inch. This motion again is doubled at the monogram and therefore, while the opening in the foot shown in FIG. 1 is two inches by two inches, the monogram or patch area used on the table 112 is eight inches by eight inches, or four fold in size and traverse.

FIG. 15 shows one of the eight drums and clutches previously mentioned in connection with FIG. 7. Drum 155 has cable 5 wound thereon. The drum has end flanges 248 and 250. End flange 250 is secured to the clutch, the latter having a cage disc 252 located between two housing discs 254, the latter having sloping cam surfaces engaged by camming rollers which are spaced around the clutch by the cage disc 252. The rollers act directly on the shaft 122, which extends through all of the drums and clutches. Axial movement is prevented by a pair of collars 256, 258 having set screws or other such means to secure them to shaft 122, but the collars are not rotatively secured to the drum and its clutch. For further details of the clutch, reference may be had to my Patent 2,965,204 mentioned above. If desired, the cable may be positively secured to the drum, as by means of a pin 260.

It is believed that the construction and operation and method of use of my improved cam generator, as well as the advantages thereof, will be apparent from the foregoing detailed description. An enlarged facsimile or other design is drawn, using simply ink on paper, and is applied in proper position on the table 112. The monogram may be applied by using scotch tape or other such simple means. The Lucite master cam strip is mounted on the carriage with the carriage in retracted position. The air motors are started and the monogram then is traced. It may be traced at varying speed, and even intermittently, without affecting the proper longitudinal proportioning of the cam tracks, because the cutting movement of the carriage depends wholly on the tracing movement when moving the monogram.

It will be understood that while I have shown and described the invention in a preferred form, changes may be made without departing from the scope of the invention, as sought to be defined in the following claims. In the claims the reference to monograms is not intended to exclude other designs. The reference to movement of a table carrying the monogram relative to a fixed pointer, is not intended to exclude an otherwise similar arrange-

ment in which the monogram remains stationary while the pointer is moved, the latter being part of or being carried by a plate which is connected to X and Y linkages. Also, the reference in some claims to the Y groove being a mirror image is not intended to exclude a similar arrangement in which Y groove is unchanged but the X groove is a mirror image, this depending of course on which groove is the bottom groove in the small cam bar used in the sewing machine attachment.

I claim:

1. A cam generator for making a cam pattern to be used for monograms, said cam being an elongated bar having two cam grooves for X and Y movement, said generator comprising a horizontally movable table on which a specimen monogram may be mounted, a pointer relative to which the table is moved to trace the monogram, an elongated cam carriage mounted for longitudinal movement and arranged to carry a blank cam bar, means including a rotatable drive shaft to move the carriage, a cutting tool movable transversely of the carriage for cutting the X groove, a cutting tool movable transversely of the carriage for cutting the Y groove, linkage between the table and the X tool for response to movement of the table in the X direction, linkage between the table and the Y tool for response to movement of the table in the Y direction, and means to rotate said shaft to move the carriage.

2. A cam generator as defined in claim 1, in which the cam bar being cut is an enlarged master cam to be used in making cam bars for a sewing machine for sewing monograms, and in which the specimen monogram is appropriately enlarged relative to the monogram to be produced by the sewing machine.

3. A cam generator as defined in claim 1, in which the means to rotate the shaft does so in response to movement of the table, there being no movement of the carriage when the table is stationary.

4. A cam generator as defined in claim 1, in which the means to rotate the shaft does so in response to movement of the table and in which the rotation of the shaft is in proportion to the amount of tracing movement of the table relative to the pointer.

5. A cam generator as defined in claim 1, in which there are cables radiating from the table in uniformly angularly spaced directions, and pulleys guiding all of the cables to drums spaced along the drive shaft, and over-running or unidirectional clutches between said drums and said drive shaft, all of said clutches engaging in the same direction of rotation, whereby at any instant the drive shaft is turned by that cable having the greatest movement at that instant.

6. A cam generator as defined in claim 5, in which there are eight cables radiating from the table at an angular spacing of forty-five degrees, and in which there are eight drums and eight clutches on the drive shaft for response to one or another of the eight cables.

7. A master cam generator as defined in claim 2, in which the X linkage is an enlarged mechanical analog of the X linkage in the sewing machine attachment in which the cam bar is to be used.

8. A master cam generator as defined in claim 2, in which the Y linkage is an enlarged mechanical analog of the Y linkage in a sewing machine attachment in which the cam bar is to be used.

9. A cam generator as defined in claim 2, in which the X and Y cutting tools are both above the master cam bar to form collateral cam grooves on top of a wide master cam bar, and in which the output of the Y linkage is reversed before being applied to the cutting tool for the Y groove, whereby the Y groove on top of the master cam bar is a mirror image of a Y groove to be formed on the bottom of the cam bar which is to be used in the sewing machine.

10. A master cam generator as defined in claim 2, in which the X and Y linkages are enlarged mechanical

analog of the X and Y linkages in a sewing machine attachment in which the cam bar is to be used, and in which the X and Y cutting tools are both above the master cam bar to form collateral cam grooves on top of a wide master cam bar, and in which the output of the Y linkage is reversed before being applied to the cutting tool for the Y groove, whereby the Y groove on top of

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the master cam bar is a mirror image of the Y groove to be formed on the bottom of the cam bar which is to be used in the sewing machine.

No references cited.

GERALD A. DOST, *Primary Examiner.*